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The flood control system of Newport, Ark.

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THE FLOOD CONTROL SYSTEM OF NEWPORT, ARK.

By

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A

THESIS

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Professor of Mining

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Vast sums each year are expended on flood control projects on the Mississippi river and its tributaries. Millions of acres that were formerly subject to annual inundation caused by overflows, have been reclaimed for agricultural purposes, and each year, an increasing amount of this sort of work must be done as quicker run off and an increased volume caused by the clearing of land and drainage of natural storage, results in higher flood stages. Of course the greatest work of this kind has been done along the Mississippi river, where great levees on each side from Missouri to its mouth protect millions of acres and thousands of people from destruction and death each year. But on many of the smaller tributaries, very interesting problems of this nature are found.

An especially interesting problem of this kind presented itself at Newport, Arkansas, and it was solved by the construction of a system of earth and concrete levees entirely surrounding the city.

Newport is situated about one hundred-fifty miles from the mouth of White river, a tributary of the Mississippi, which rises in the Ozark Mountains and empties into the Mississippi near the Arkansas-Louisiana boundary line. It is a city of the second class with a population of about fifty five hundred, and has a cotton oil mill, two cotton compresses, three saw mills, two stave factories, a veneering plant, a button factory, three railroads, two cotton gins, a foundry and machine shop and two handle factories. It is the County Seat and principal trading point of Jackson County and is surrounded by some of the best farming land in the State, and is an important cotton market.

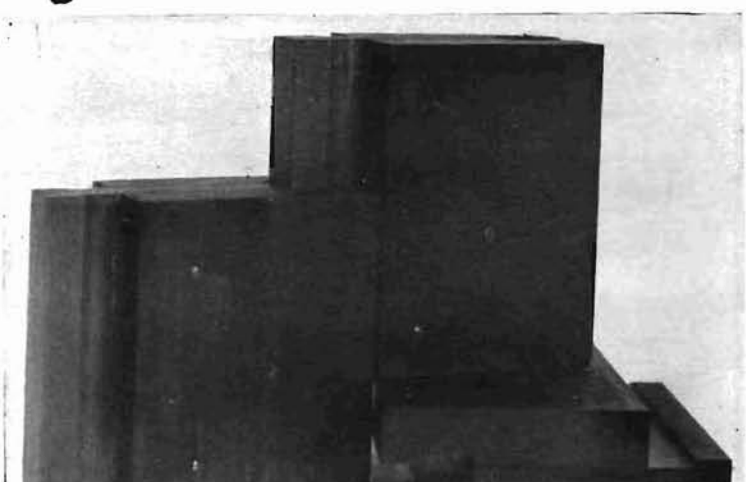
Newport has always been more or less subject to annual overflows of the White River, and two especially disastrous floods occurred in 1915-1916. In August 1915, White River began to rise very rapidly and within less than two weeks the city of Newport was covered with water ranging in depth from about six feet in the main business district to ten and twelve feet in parts of the residential district. At this time the government gauge showed 34.2 feet above average low water mark. This condition lasted for about six days and then the water began to gradually recede. During these six days, there was no train service either to or from Newport, and the property damage was estimated to be at least $125,000.00. Then, in the following February, there was a second overflow with the river gauge showing 34.6 feet. Immediately after the high waters receded, there was a meeting called at the offices of Stayton & Stayton of about twenty of the largest tax payers of the city, and arrangements were made at this meeting for calling a general mass meeting to be held at the Court House. At this mass meeting, the present levee district was formed and the commissioners were selected. The commissioners, with the help of Attorneys drew up a special Act and presented it to the State Legislature at its next meeting and the Act was passed, creating the levee district in February 1917.

The commissioners then obtained the services of the Morgan Engineering Company as the engineers on the project. The situation was studied carefully by the engineers and topographical surveys were made, and a general plan for protection by means of a system of earth levees substituted by a concrete levee wall when the earth levees were not practical because of lack of room, was designed and submitted as a solution of this flood control problem. This was accepted by the commissioners and sufficient bonds to cover the cost of the work were sold and the contract was let to Walter H. Denison and work was started immediately.

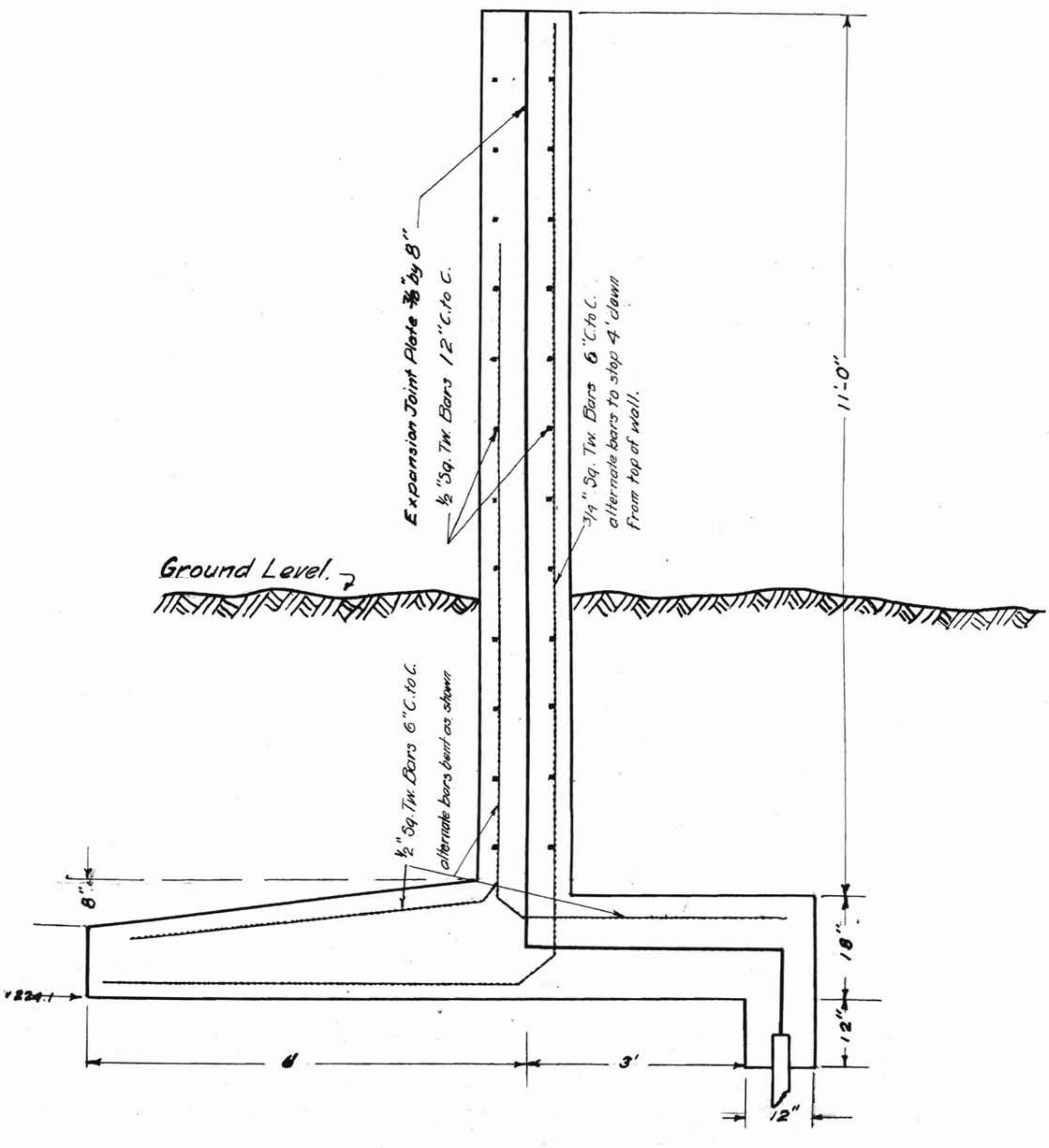
The earth levees were first constructed

along the back part of the city, as the front part was protected for a gauge of thirty feet by the natural high bank of the river and the embankment of the Missouri Pacific Railroad through the city. These earth levees were constructed to an elevation equivalent to 38.5 feet on the river gauge. The slope of the embankments was 2 1/2 to 1, and the crown was six feet wide and the average height of the whole earth levee system was about ten feet. Where the material was of such a nature that seepage would be probable, a muck ditch was constructed six feet wide and six feet deep, running lengthwise in the center of the base of the levee, and filled with suitable material to prevent seepage. On the construction of these levees 10% was allowed for shrinkage and after completion, the embankments and crown were sodded to protect from washing and sluffing. To take care of inside drainage ten flood gates, varying in size from twenty four inches to forty eight inches, were installed. Coffin sluice gates were used for this purpose.

The front part of the system, which runs through the railroad yards, due to insufficient space for the earth levee, was constructed of concrete. This concrete levee wall was constructed eleven feet high above the top of the base and fourteen inches thick, the base was eighteen inches thick and ten feet wide, with reinforcing steel placed as shown by the sketches on the following sheet. The average height of the wall above ground surface was about seven feet. A sketch of the Martinez interlocking sheet piling is also shown. Twelve foot lengths of this piling were driven on the river side, as shown in the sketches, to prevent seepage and to keep the base dry and to prevent the wall from slipping out of place when the water got up high enough to exert considerable force against the wall.



Martinez Piling


Expansion Joint Plate 7/8" by 8"
½" Sq. Tw. Bars 12" C. to C.
3/4" Sq. Tw. Bars 6" C. to C. alternate bars to stop 4' down from top of wall.
Ground Level.
½" Sq. Tw. Bars 6" C. to C. alternate bars bent as shown
11'-0"
8"
18"
12"
6'
3'
12"

Due to the necessity of conserving space a heavily reinforced contilever section was used as shown in sketch. To take care of the expansion stresses 1/2 inch steel was placed two inches from each wall at intervals of twelve inches from top to bottom. Vertical steel was bent so that it could be placed two inches from the river side of the wall and two inches from the bottom of the base and extending back to six inches of the end of the land side of the base, and was spaced five inches apart alternate bars extending within four feet of the top of the wall. Horizontal steel extending across the base and placed two inches from the top was spaced every foot. The piling was driven six inches below the top of a twelve inch trench which resulted in the base being firmly tied to the piling. The wall was designed so that the entire base and part of the wall would be below original ground surface.

This concrete levee wall was started Jan. 8, 1922 and the contract was completed by April 1st. Only two weeks were lost due to extremely cold weather. During ordinary freezing weather a Hauck No. 90 kerosene heater was attached to the mixer and was found to be ample for thawing out frozen lumps and removing frost from the materials. With this heater the mix was produced hot and uniform, and the temperature could be raised to one hundred degrees Fahrenheit if desired and the speed of mixing lowered only about 15%.

The wall was almost thirty four hundred feet in length and contained three thousands yards of concrete, one hundred fifty thousand pounds of reinforcing steel and about fifteen thousand pounds of miscellaneous steel, such as angle irons and expansion joint metal. After the wall was poured and the forms removed, all form marks were obliterated by rubbing with carborundum bricks.

Each car of cement received was sampled and samples sent to Memphis to be tested. Two different tests were required, a seven day test must stand two hundred pounds per square inch tension, and a twenty eight day test must stand three hundred pounds per square inch tension. Each car of gravel and sand received was inspected by the engineer and had to receive his O. K. before being used.

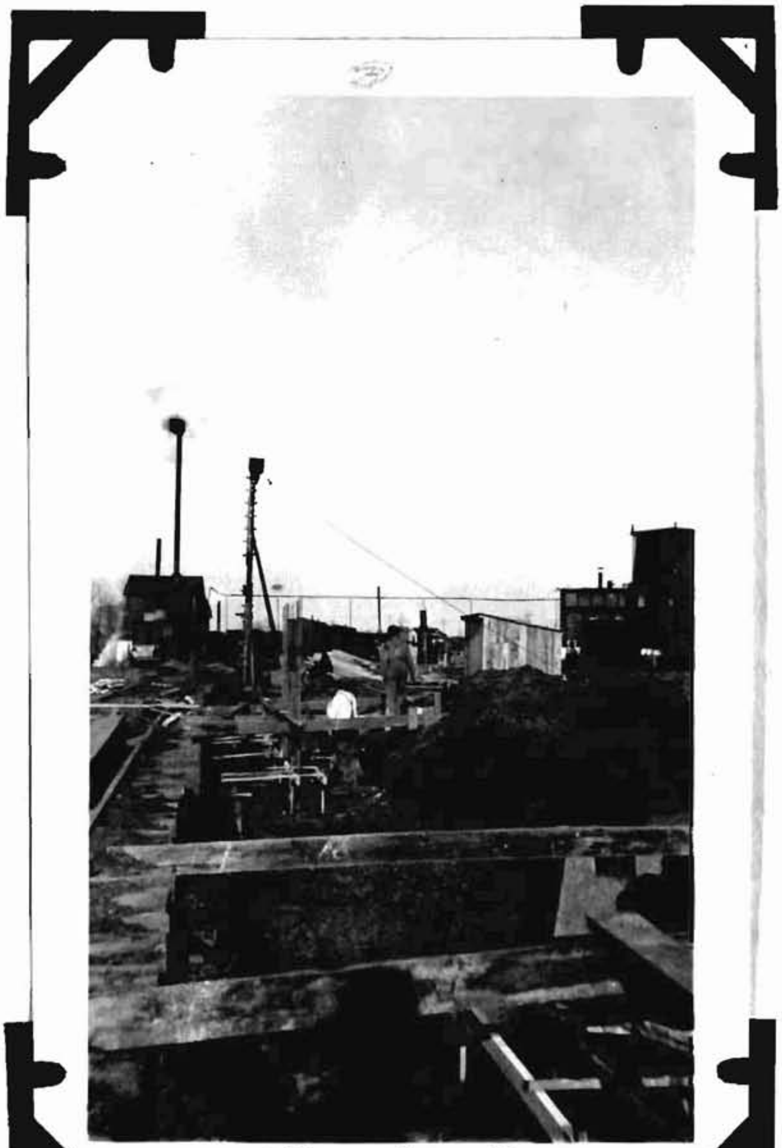
CONSTRUCTION.

For driving the piling, a No. 3 Vulcan

steam hammer swung in twenty seven foot **leads** **was** used.

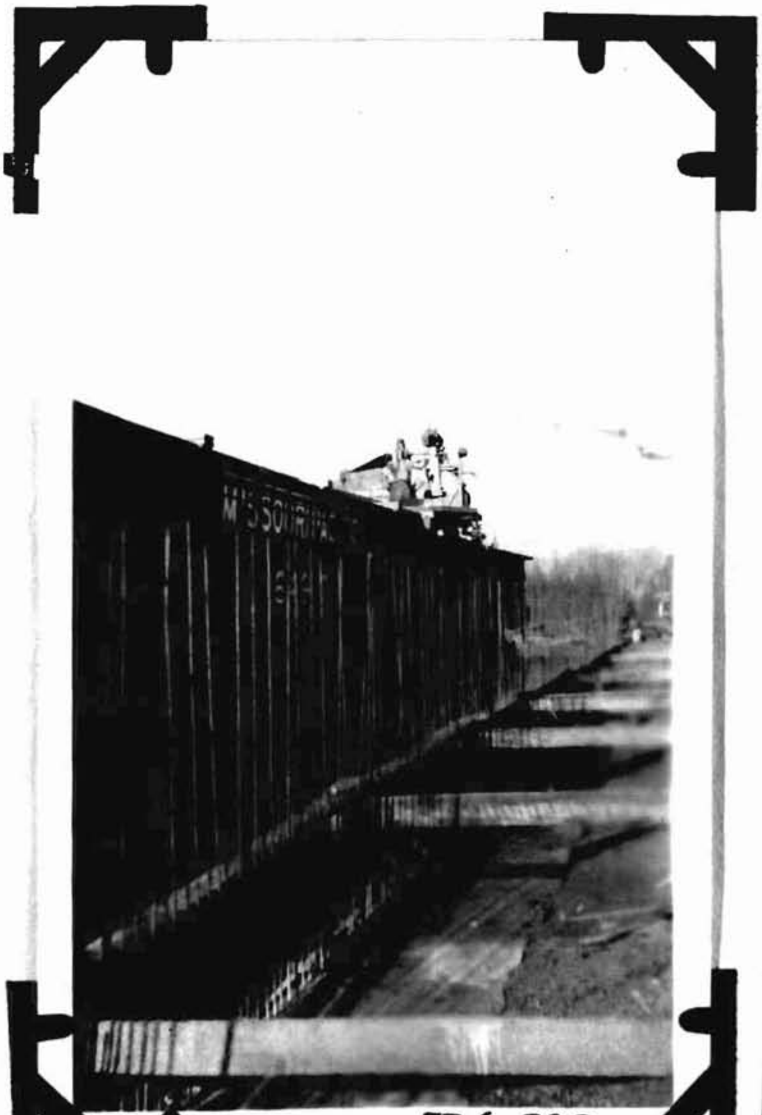
View No. 57-3-22 shows the hammer in the leads and the method of mounting the driver. The driver was mounted on two wooden rollers twelve inches in diameter three foot seven inches long with 6 1/2 inch bearing surface on each end, each of these rollers had three, two inch holes through them, staggered to give maximum strength, a short piece of boiler flue was placed in each of these holes and the ends split and bent down so that they could not come out. The driver was moved on these rollers to proper position for driving the next piling by inserting a rod,in one of these holes in each roller,and using them as levers. To prevent the driver from overturning when the hammer was drawn up to insert a new piling, a counter weight was used, a block of concrete weighing about sixty five hundred pounds, and an additional control was a guy rope attached to the top of the leads and fastened to some available deadman. It required about two minutes actual driving to drive a twelve foot piling through stiff clay. The speed of the hammer was about sixty five strokes per minute, with length of stroke thirty inches and weight of drop hammer eighteen hundred pounds.

After the piling was driven the base was cleaned of all mud and the ends of the piling thoroughly cleaned and two by fours were set to the grade of the top of the base and in line with each side of the wall, by nailing them to stakes driven in the ground. The vertical steel, shown in sketch on page six, was then placed and wired to a frame as shown in view No. 57-4-22 on next page. Headers were then placed every forty two feet and a 3/8 by 8 inch steel plate fastened in such a position so as to be in the center of the wall, half in one joint and half in the next, and extending from the top of the wall to the center of the base and bent so as to extend across the base and down to the top of the piling.



57-4-22

A one bag Koehring Dandy mixer was used for mixing the concrete on this job. One section was poured and the next section was skipped until the following day when the concrete had a sufficient set for the header to be removed and the expansion joint material could be placed, and that section poured. The concrete was poured until it was level with the lower edge of the two by fours as shown in view 57-6-22 on page 13, then the two by fours were partly filled with concrete and another two by four was laid in the center to produce a groove for the proper bonding of the wall to the base. After the concrete had obtained sufficient set to hold up the two by fours, the stakes that held them in position were removed and the concrete spaded to fill the holes from where they were removed. After the section had set forty eight hours, the two by fours were removed and groove thoroughly roughened with a pick or mattock. View No 57-7-22 shown on page 13, shows the rods imbedded in the base and the roughened groove. The 3/8 by 8 inch steel plates for the expansion joint can be seen swaying out to the right of the line of reinforcing steel. The forms for the wall were then placed on one side and lined up and braced solidly, struts that were of the same length as the wall was in thickness were then nailed to the forms to hold the two sets of forms the proper distance apart, wires were



57-6-22

57-7-22

then run through holes in the forms and by means of wedges were drawn tight, so that the forms could not bulge when the concrete was poured in them. These struts were knocked out gradually from the bottom of the forms and speared with a pole with a nail in the end of it, as the concrete began to rise enough in the forms to hold them apart. View No. 57-8-22 shows one side of the forms in place and struts nailed to them preparatory to placing other side of forms.

57-8-22

On the part of the wall that did not parallel the railroad tracks, a skip was used to elevate the concrete to the top of the forms. This skip was 20" by

20" by 48" in length at the bottom and 20" at the top, double track was used, the front wheels being narrower than the other. This was operated by an auxiliary hoist driven off the drum of the mixer. The plant that supplied the power for the mixer was a Fuller & Johnston 6 H.P. gasoline engine.

57-9-22

View No. 57-9-22 shows the skip dumping a load of concrete into the forms. The boiler that is shown at the rear of the mixer supplied the steam for this pile driver described on page 10. After the wall was completed up to where it paralleled the railroad tracks the mixer was mounted on a gondola car, the top of which was completely boarded over, with three inch material and braced underneath to prevent sagging.

A novel scheme for distributing concrete was worked out by erecting three chutes as shown in view No. 57-11-22, material could be placed at either end of the sec-

57-11-22

tion and at the center by closing two of the chutes with slides. When sufficient material was placed from one chute the end was closed by a hand slide and material directed through another. This insured minimum handling of material for proper placing in base.

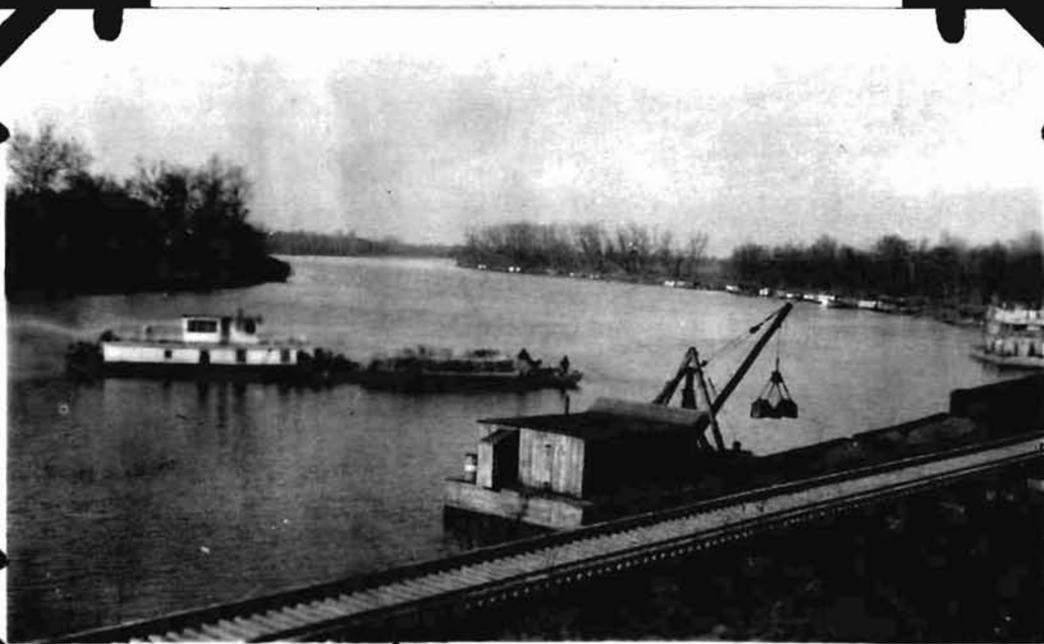
Material was handled directly from cars by building temporary platforms and wheeling it to the mixer as shown in view No. 57-13-22.

57-13-22

When a car of sand or gravel was emptied the platforms were removed and placed on mixing car, the empties were then replaced with loaded cars by the railroad switching crew. The mixer was high enough to pour directly into the wall forms as shown in No. 57-12-22, no elevating of materials or concrete was necessary.

57-12-22

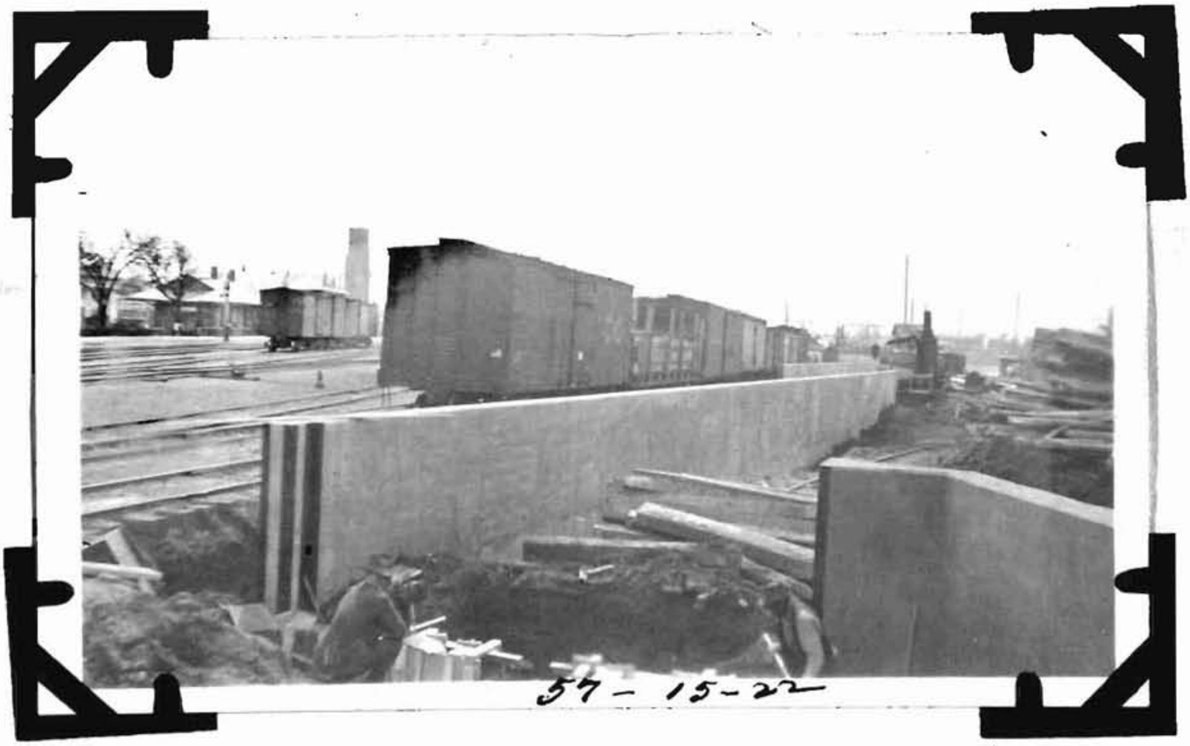
The gravel and sand used in this work was obtained from White river and unloaded from barges directly into the cars used on the work. Unloading outfit is shown in view No. 57-14-22 on page 19. The river is shown at low water stage.



57-14-22

It was necessary to install four openings for track crossings. This was done by constructing a sill to an elevation of the bottom of the tie with a four inch groove in it, between the wall ends. A vertical groove faced with four inch angle irons was constructed in the wall ends, and in time of high water a short section of track is removed, dirt cleaned from groove in sill and four inch creosoted gate planks inserted in the groove.

These planks being built up of two inch material to make a ship lap joint, a removable steel post placed in a concrete foundation supports these wooden gates in the center when water pressure makes such support necessary. An opening with track removed is shown in view No. 57-15-22.



57-15-22

A panoramic view of the completed wall is shown in views Nos. 57-191 and 57-192.

57-191

57-192

GENERAL SPECIFICATIONS.

(1) Equipment.

The contractor shall install plant and equipment of such size and character that the required rate of progress can be maintained, and a satisfactory quality of work can be done; and he shall at all times use all reasonable appliances and ingenuity and shall go to every reasonable expense to prevent delay.

(2) Direction of the work.

The Engineer in charge shall have the right to direct the manner in which all the work is to be conducted in so far as may be necessary to secure the proper progress and quality of the work.

(3) Inspection of work.

All work and material furnished shall be subject at all times to a thorough and minute inspection by the Engineer. The contractor shall furnish access at all times to every part of the work and to all points where materials to be used in the work are manufactured, procured and stored.

(4) Damaged and defective work and materials.

If the work should be damaged in any way or if defects develop before the final acceptance of the whole work, the Contractor shall correct such damage or defect without additional compensation. Any materials delivered at the site for use in the work, that may be condemned by the Engineer, shall be immediately removed from the site by the Contractor. If the Contractor shall fail to reconstruct any defective or damaged work after reasonable notice, the Engineer may cause such work to be reconstructed and the expense thereof shall be deducted from the amount to be paid the Contractor.

DETAIL SPECIFICATION.

(1) Excavation and backfill.

This item shall include all excavation and backfill required in the construction of the concrete retaining wall or other walls, culverts, sluiceways, flood gate structures and all similar structures. All excess excavated material not required for backfill shall be leveled down or otherwise disposed of by the Contractor in a manner satisfactory to the Engineer.

PLAIN CONCRETE

(1) Description.

This item shall include all concrete in which reinforcement is not used. The concrete shall be composed of cement, fine aggregates, coarse aggregates, and water of the qualities hereinafter specified, and mixed in proportion by volume of 1 of cement, 2½ of fine aggregates, and 5 of coarse aggregates. The Contractor shall use only such materials, satisfactorily proportioned, mixed and placed as the Engineer may direct. From time to time tests may be made both of the materials in advance of the construction and also of the concrete actually being placed in the work.

(2) Cement.

Cement shall mean Portland cement, as defined by the Standard Specifications for cement of the American Society for testing materials, revised to 1909 and published in the year 1915 book of that society.

(3) Fine Aggregate.

Fine aggregate or sand shall be composed of grains from hard, tough, durable rocks, free from soft, decayed, friable or soluble material. It shall be clean and shall not contain a sufficient quantity of organic silt, clay, or other finely divided matter to render it unsuitable. If objectionable quantities of silt or other matter adhere to the sand grains, the sand shall be satisfactorily washed. The size of the grains shall be acceptably graded from fine to coarse particles with no grains larger than will pass a one fourth inch mesh screen. The use of limestone screenings will not be allowed.

(4) Coarse Aggregate.

Coarse aggregate shall consist of clean, hard, durable, insoluble broken stone or gravel, of such size as to pass thru a screen having 2½ inch round holes and to be retained on a one-fourth inch mesh screen. It shall be acceptably graded in size between the limits prescribed. Fragments of approximately the same size; or of flat, elongated shapes, or improperly graded, will not be satisfactory. Such screenings, grading and washings shall be resorted to as will produce material of acceptable quality. Run of crusher or run of bank or bar, i.e.

gravel or stone containing a mixture of both the fine and coarse aggregates, shall not be used without screening.

(5) Water.

The water used in mixing concrete shall be clean and free from oil, acid, strong alkalies or vegetable matter.

(6) Preparation of Foundations.

No concrete shall be placed until the foundation is prepared to the satisfaction of the Engineer.

If required by the Engineer earth foundations shall be thoroughly compacted and in no case shall the Contractor deposit concrete or newly placed fills on such as, in the opinion of the Engineer, are likely to shrink or settle in a manner which may injure the concrete structure. Earth foundations shall be thoroughly and satisfactorily welted immediately prior to placing the concrete thereon. If frozen, the soil shall be thawed out in a satisfactory manner, and then thoroughly compacted even though this may habe been done previous to freezing.

(7) Mixing.

Concrete shall be mixed in approved mechanical batch mixers, in batches of suitable size, except that, when permitted, it may be mixed by hand in a thorough and satisfactory manner.

All operations incidental to mixing concrete shall proceed with sufficient dispatch to insure the bonding together of the successive batches as a true monolith. In determining proportions of ingredients, 100 pounds of cement shall be considered one cubic foot. The coarse and fine aggregates shall be measured separately and uncompacted, in approved measuring boxes. The entire batch shall remain in the mixer not less than sixty seconds and longer if necessary to secure a thoroughly satisfactory mix.

(8) Forms.

The contractor shall provide and maintain in good condition all necessary forms, molds and centers for shaping the concrete. Such forms shall be true to the required shapes and sizes, properly braced and strong enough to withstand without warping all operations incidental to placing the concrete. The contact surfaces of all forms, whether of wood or steel, shall, where required, be coated with soap, mineral oil, or other suitable substances wherever required, forms shall be thoroughly wet before placing concrete, so as to prevent injurious drying of the surface of the concrete. Forms shall not be removed until the Engineer has approved such removal, but the contractor shall be responsible for all injury to concrete due to their prevenative removal.

(9) Placings.

Provision shall be made for the rapid transportation of fresh concrete from the point of mixing to the work. Care shall be taken in conveying and depositing concrete to avoid methods which tend to produce a segregation of the component parts.

(10) Contraction Joints.

Contraction joints, expansion joints and slip joints shall be formed where and as directed in concrete structures.

In general, such joints hall be made by building smoother surfaves, acceptably coated, if required with some approved substance to render them inadhesive, and shall be grooved or otherwise shaped as directed, or shall have metal strips enbedded therein.

(11) Finishing Surfaces.

Unless otherwise specified, all concrete surfaces which are to remain permanently exposed shall be given a neat appearance by removing in an approved manner all rough edges and projections. Honeycombed sections shall either be painted up with cement mortor or taken out and the spaces refilled with concrete or mortor as the Engineer may direct.

(12) Cold weather Precautions.

Concrete shall not be mixed or deposited during freezing weather or without the specific direction or permission of the Engineer. When so directed or permitted, approved precautions shall be taken for removing snow, ice or frost from the materials and from the surface upon which the concrete is to be placed.

ITEM 3, REINFORCED CONCRETE.

(1) Description.

This item shall include all concrete in which steel reinforeement is imbedded. Reinforced concrete shall be composed of a mixture of the same materials as plain concrete, except that the proportions by volume shall be one of cement, two of fine aggregate and four of coarse aggregate, and in addition thereto, shall have imbedded in it, reinforcing steel or other structurial steel shapes.

(2) Provisions.

All provisions of Item 2 shall apply to reinforced concrete, Item 3, except that coarse aggregate shall be of such size as to pass through a screen having $1\frac{1}{2}$ inch round holes, and be retained on a 1/4 inch mesh screen.

(3) Placing reinforcing.

There shall be thoroughly embedded in the concrete reinforcing steel or other structural steel shapes in the position shown on the drawings required by these specifications, or ordered by the Engineer.

ITEM 4, REINFORCING STEEL.

(1).

Steel reinforcement for concrete shall be free from mill scale, and shall strictly fulfill all the requirements and be subjected to all the tests for the structural steel grade given in the standard specifications for Billet Steel Concrete Reinforcement Bars, as published in the 1915 Year Book of the American Society for testing materials. Bars shall be twisted or otherwise deformed and of the sizes and weights shown on the Drawings, and shall be secured in the positions required, in an approved manner, so as to withstand, without displacement the pouring and spading of concrete, until completely embedded.

ITEM 5, WOOD SHEET PILING.

(1) Quality and materials.

Tongue and groove wood sheet piling shall be of long leaf yellow pine of a grade equal to that known commercially as No. 1 or No. 1 Common. The thickness of the piling shall not be less than three inches.

(2) Driving.

Piling shall be driven to the depths shown on the Plans or as ordered by the Engineer, and in a manner satisfactorily to the Engineer.